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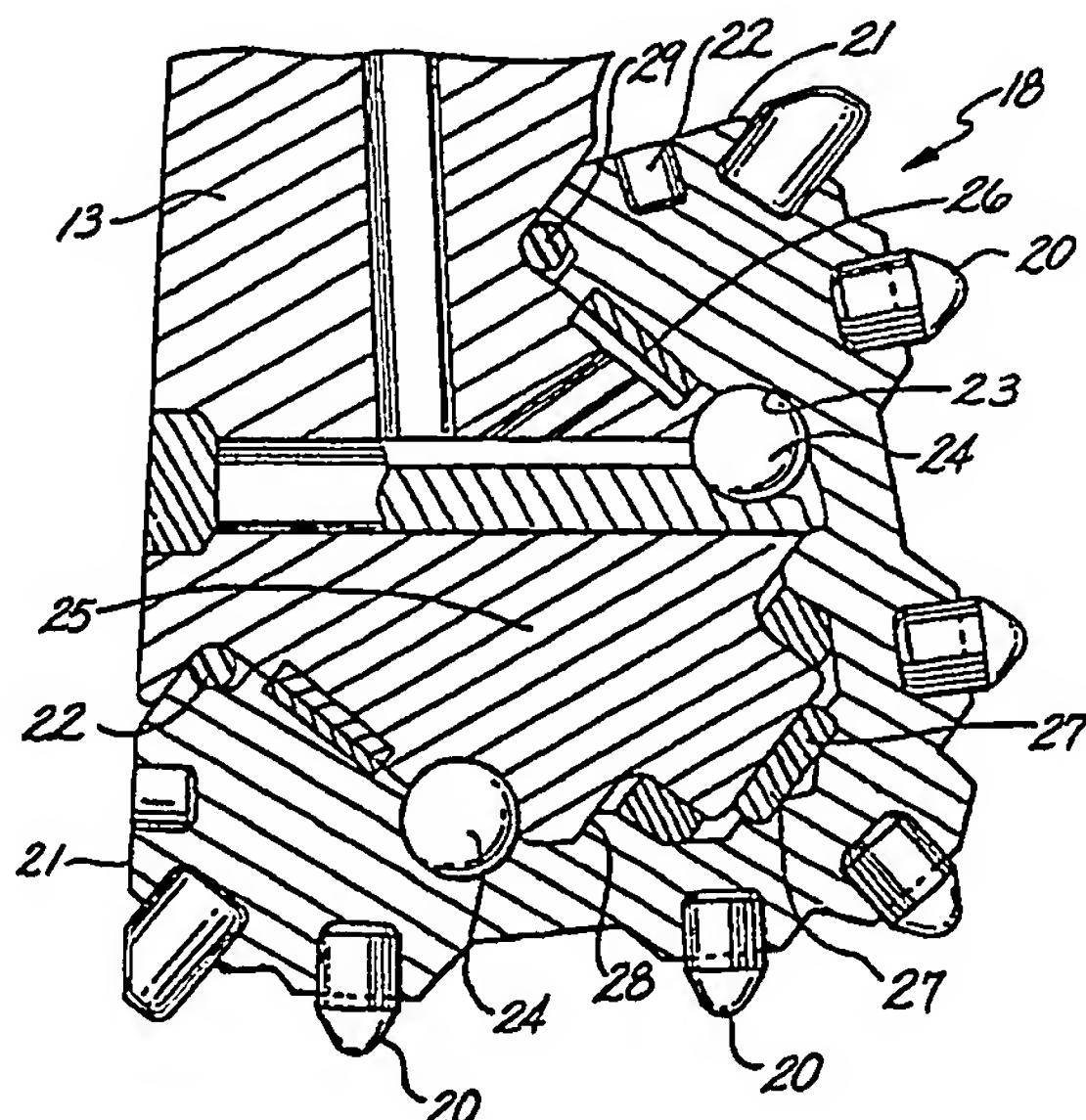
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(54) Improved gage protection for rock bits

(57) A rotary cone drill bit is disclosed as having ultra hard gage maintaining cemented tungsten carbide inserts which are formed from tungsten carbide powder having an average grain size of less than 1.0 micron, preferably in the range of from 0.05 to 0.5 microns cemented with Co, Ni or Fe. Preferably, the carbide is cemented with less than 16 weight percent cobalt. Such inserts have a hardness from 92.5 Rockwell A to 97.0 Rockwell A as compared with less than 92 Rockwell A for previous inserts. These heel row inserts significantly increase the wear resistance of the bit gage surfaces. When used in compression on the gage heel row these inserts will withstand the high impact loads encountered in hard tough rock bit drilling.

Fig. 2



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Fig. 1

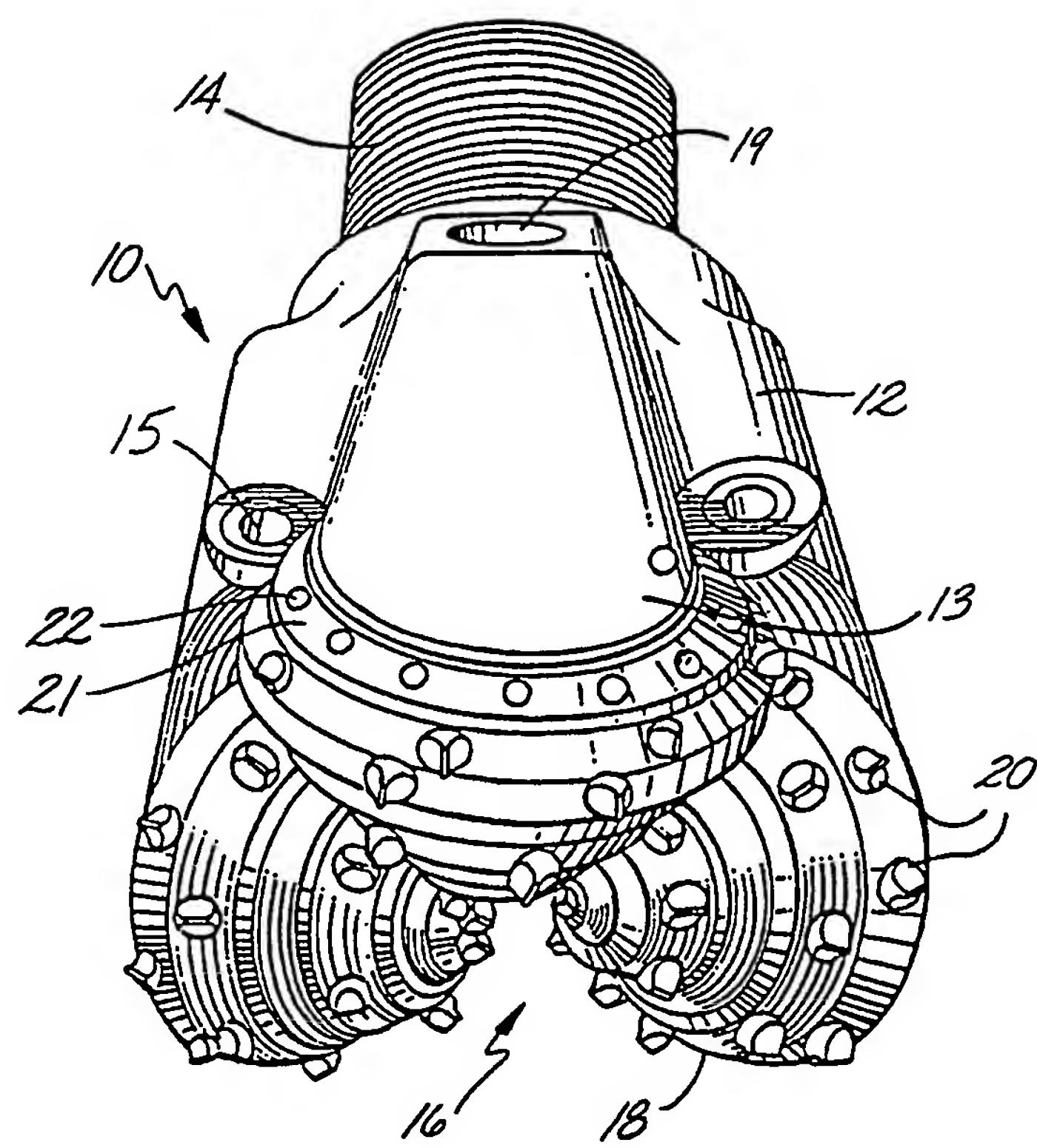
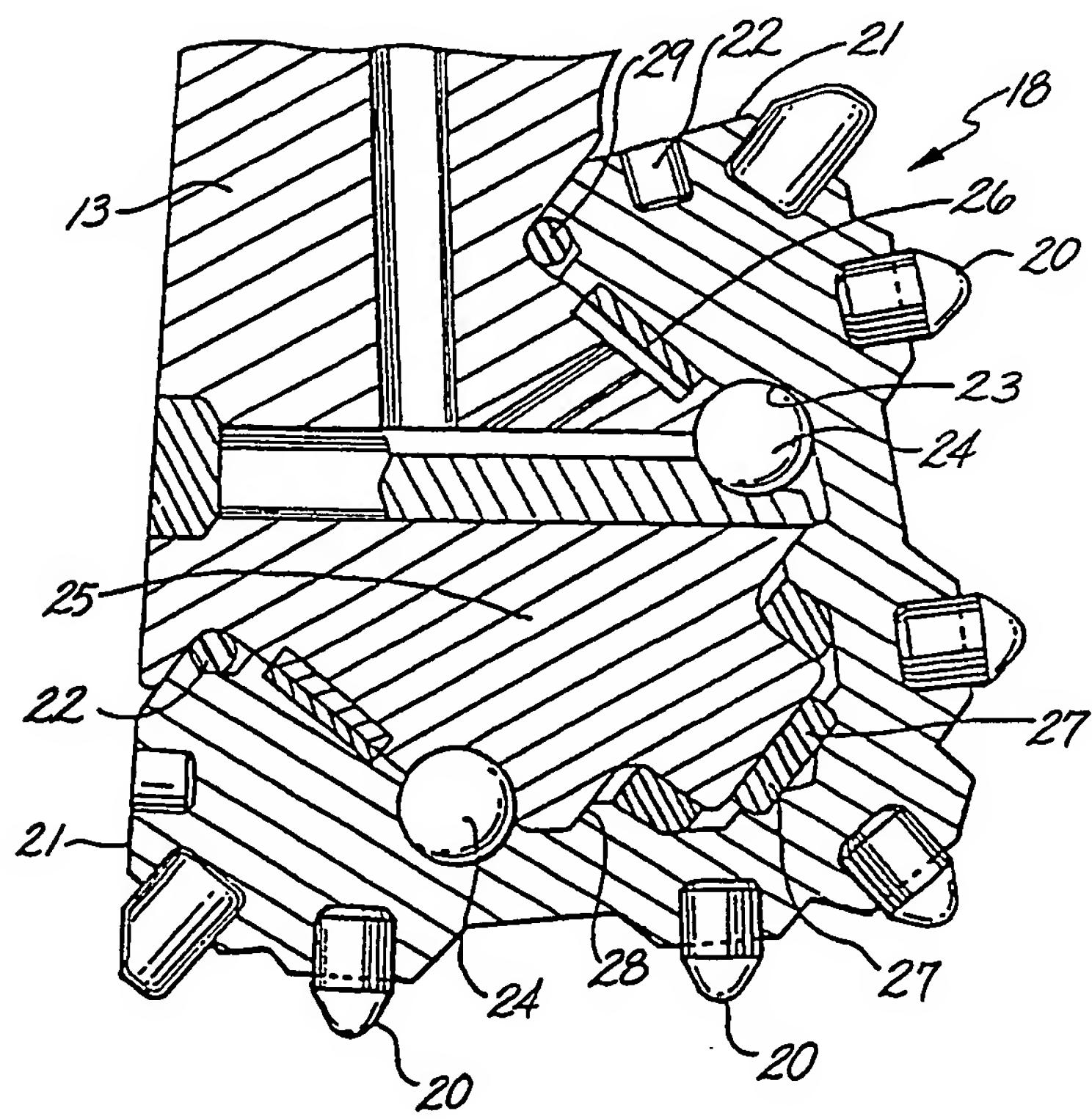


Fig. 2



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10 IMPROVED GAGE PROTECTION FOR ROCK BITS

The present invention relates to rotary cone rock bits having hard metal cutter inserts positioned on the 15 rotary cones of a rock bit.

More specifically, this invention relates to very hard, wear resistant cemented tungsten carbide inserts fitted particularly on the heel surface of a rotary cone for a rock bit. The heel surface of a cone for a roller 20 cone bit, on which the tungsten carbide inserts are positioned is the only surface on the roller cone that is essentially perpendicular to the borehole bottom and parallel to the bit centerline at the moment of rolling contact of the heel surface with the borehole wall. In 25 the drilling industry, maintenance of the gage circumference of a borehole is essential to prevent pinching of subsequent rock bits as they are lowered into the borehole for continued drilling. If the heel row of inserts of a roller bit becomes worn, the rock 30 bit begins to drill an undersize borehole. Replacement of a worn rock bit with a new bit having a gage diameter that is larger than the gage of the borehole cut by the previous undersize rock bit means that the bit engages the wall of the borehole before it reaches 35 the bottom. Consequently, as the new bit is lowered into the formation it becomes pinched, resulting in either catastrophic failure of the rock bit or

1 drastically reduced rock bit life.

It is well known in the art to provide hard, wear
resistant gage protection on the heel rows of the
roller cones of a rock bit. For example, U.S. Patent
5 No. 3,727,705 describes cylindrical tungsten carbide
inserts positioned on the gage heel row of a roller
bit. This patent shows using standard hard (<92
Rockwell A) carbide heel row inserts positioned at
different spacings and diameters on the heel row
10 surface of each roller cone of the drill bit. This
provides more dense and broader contact area of the
inserts in contact with an abrasive earthen formation
wall while drilling. Although this does provide
somewhat better gage wear protection, it still has
15 insufficient wear resistance to maintain bit gage
diameter when drilling many very hard and abrasive
rocks.

U.S. Patent No. 4,940,099 shows using normal hard
grade (<92 Rockwell A) tungsten carbide heel row
20 inserts alternating with softer grade tungsten carbide
inserts having polycrystalline diamond (PDC) outer wear
surfaces. While this arrangement does improve wear
resistance of the bit gage surfaces in some applica-
tions, PDC insert breakage is still a serious problem
25 because of the high impact loads encountered while
drilling extremely hard and tough rock.
Polycrystalline diamond is extremely hard but very
brittle. Its impact strength is an inverse function of
its hardness.

30 It would be desirable to mitigate premature wear
and/or breakage of the gage maintaining heel row
cemented carbide inserts of a roller cone rock bit,
thereby assuring a full gage well bore.

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There is therefore provided in practice of this
invention a carbide insert for use in a gage

1 maintenance row of a rock bit comprising a cemented
tungsten carbide powder with an average grain size of
less than 1.0 micron. Preferably, this powder has a
size range from 0.05 micron to 0.5 micron and a metal
5 binder selected from the group consisting of cobalt,
nickel and iron.

The present invention is one relating to rotary
drill bits in which tungsten carbide cutting inserts
are rigidly affixed in sockets in rotatable cones.
10 Further, a group of inserts in each cone define a heel
or gage reaming row. These heel row inserts are made
of cemented tungsten carbide having hardness ranging
from 92.5 Rockwell A to 97.0 Rockwell A, which is
significantly harder than inserts in present use,
15 therefore making them superior for gage wear
maintenance of a rock bit roller cone gage surface.

These heel row tungsten carbide inserts also have
the toughness to withstand the high drilling impact
loads that often fracture the prior art polycrystalline
20 diamond compact heel row inserts.

These and additional features and advantages of
this invention will become more fully apparent in the
25 following description when considered in conjunction
with the accompanying drawings wherein:

FIGURE 1 is a perspective view showing a roller
cutter drill bit that embodies the principles of the
invention; and

30 FIGURE 2 is fragmentary view in longitudinal
section of roller cutter drill bit having a rotatable
cutter cone supported thereon.

35 Figure 1 illustrates a rotary cone rock bit 10
fitted with tungsten carbide cutting inserts generally
designated as 20. The bit consists of a bit body 12

1 threaded at a pin end 14 and having a cutting end
generally designated as 16. Each leg 13 on the bit
body supports a rotary cone 18 rotatably retained on a
journal 25 cantilevered from each of the legs (Fig. 2).
5 The tungsten carbide drilling inserts 20 are, for
example, rigidly affixed in circumferential rows on
each of the rotary cones. Typically, these inserts as
well as the heel row inserts 22 are press fitted under
10 compression into insert retention sockets formed in the
cones. The heel row gage reaming inserts 22 are
rigidly mounted on the outer gage surface 21 of each
rotary cone 18. The heel row inserts are essentially
flush with the gage surface 21 of the rock bit roller
cone 18.

15 The rock bit 10 further includes a drilling fluid
passage through the pin end 14 that communicates with
a plenum chamber (not shown) inside the body.
Typically one or more nozzles 15 are secured within bit
body 12. The nozzles 15 direct drilling fluid from the
20 plenum toward a borehole bottom. The upper portion of
each of the legs 13 may have a lubricant reservoir 19
to supply a lubricant to each of the rotary cones 18.

As shown in Figure 2, each rotary cone head
section 18 has ball bearings 24 positioned in a raceway
25 23 to rotatably affix the cone 18 to the journal 25.

Further bearing means are provided, such as the
main journal bearing 26, the journal nose thrust button
27 and the journal thrust washer 28. Sealing means,
such as an O-ring 29, are used to retain lubricant in
30 the bearings and to exclude contaminants.

A plurality of tungsten carbide drilling inserts
20 are rigidly affixed in circumferential rows on each
rotary cone 18. The gage maintaining heel row inserts
22 are rigidly mounted in compression and are normal to
35 and essentially flush with the gage surface 21 to
provide gage wear protection and to maintain a full
gage well bore.

1 New technology has now made possible the
manufacture and use of tungsten carbide (WC) powders
considerably smaller than 1.0 micron, having a size
range of 0.05 micron to 0.5 micron. This is many times
5 smaller than the greater than one micron powders
currently used in the hardest grade (90.0 Rockwell A to
92.5 Rockwell A) cemented carbide inserts for rock bit
gage protection. Using these new ultra fine grained WC
powders with appropriate grain growth inhibitors (such
10 as vanadium carbide), and an appropriate binder such as
cobalt (less than 16% by weight), ultra hard (92.5
Rockwell A to 97.0 Rockwell A) cemented tungsten
carbide inserts can commercially be made. Although
tungsten is the preferred carbide former for use in
15 this invention, carbides of all the metals in Group IV
A, V A, and VI A of the periodic system, or an alloy
thereof, can theoretically be used for this purpose.
Also cobalt is the preferred binder metal for use in
this invention, but nickel and iron can be used
20 advantageously.

The carbide heel row inserts 22, described above,
have the toughness to withstand high impact drilling
conditions when used in compression of a press fit
heretofore described.

25 It should be apparent from the foregoing
description that the present invention provides
significant advantages. When drilling very tough
abrasive rock formations these novel carbide gage
reaming inserts 22 have the hardness to provide
30 significantly better gage wear protection for a rock
bit than do state of the art tungsten carbide gage
inserts; thereby greatly extending the useful life of
the bit. Under very high impact drilling conditions
this invention can withstand much higher impact loads
35 without breakage than do polycrystalline diamond
compacts. This also significantly extends the useful
life of the bit.

1 It will of course be realized that various
modifications can be made in the design and materials
of the present invention without departing from the
spirit thereof. Thus while the principal preferred
5 construction and materials of the invention have been
explained and illustrated in what is now considered to
represent its best embodiments, it should be understood
that within the scope of the appended claims, the
invention may be practiced otherwise than as
10 specifically illustrated and described.

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1 CLAIMS

5 1. A cemented tungsten carbide insert for use in
a rock bit comprising tungsten carbide powder with an
average grain size of less than 1.0 micron and a metal
binder selected from the group consisting of cobalt,
iron and nickel.

10 2. A rotary cone rock bit comprising:
a bit body;
at least one rotary cutter cone mounted for
rotation on the bit body;
a plurality of cemented carbide cutting inserts
mounted in the cutter cone; and
15 a plurality of cemented carbide gage inserts in a
gage maintenance row on the cutter cone, such a gage
insert comprising a carbide powder with an average
grain size of less than 1.0 micron and a metal binder
selected from the group consisting of cobalt, iron and
20 nickel, said gage insert having a hardness in the range
of from 92.5 Rockwell A to 97.0 Rockwell A.

25 3. The rotary cone rock bit as set forth in
Claim 2 wherein said carbide powder is formed from a
metal selected from Groups IV A, V A, VI A of the
periodic system or an alloy thereof.

30 4. The rotary cone rock bit as set forth in
either one of Claims 2 or 3 wherein the carbide powder
is formed from tungsten.

35 5. The rotary cone rock bit as set forth in any
of the preceding claims wherein the metal binder is
cobalt.

- 1 6. The rotary cone rock bit as set forth in any
of the preceding claims wherein the cobalt content is
less than 16 percent by weight.
- 5 7. The rotary cone rock bit as set forth in any
of the preceding claims wherein the particle size of
the carbide is in the range of from 0.05 to 0.5
microns.
- 10 8. A method of enhancing the wear resistance and
toughness of sintered cemented carbide inserts
comprising the steps of;
 compacting ultra fine tungsten carbide particles
having an average grain size of less than 1.0 micron,
15 cementing said ultra fine particles with a cobalt
metal binder, and
 sintering said carbide particles and said metal
binder into suitable insert shapes.
- 20 9. A cemented tungsten carbide insert for use in
a gage maintenance row of a rock bit comprising
tungsten carbide powder with an average grain size of
less than 1.0 micron and a metal binder of cobalt being
less than 16 percent content by weight.
- 25 10. The insert as set forth in Claim 9 wherein
the carbide insert has a hardness from 92.5 Rockwell A
to 97.0 Rockwell A.
- 30 11. The insert as set forth in Claim either one
of Claims 9 or 10 wherein the particle size of the
carbide is in the range of from 0.05 to 0.5 microns.
- 35 12. An insert for use in a rock bit substantially
as described herein with reference to the accompanying
drawings.

Amendments to the claims have been filed as follows

1. A rotary cone rock bit comprising:
 - a bit body;
 - 5 at least one rotary cutter cone mounted for rotation on the bit body;
 - a plurality of cemented carbide cutting inserts mounted in the cutter cone; and
 - 10 a plurality of cemented carbide gage inserts in a gage maintenance row on the cutter cone, such a gage insert comprising a carbide powder with an average grain size of less than 1.0 micron and a metal binder selected from the group consisting of cobalt, iron and nickel, said gage insert having a hardness in the range
 - 15 of from 92.5 Rockwell A to 97.0 Rockwell A.
2. The rotary cone rock bit as set forth in Claim 1 wherein said carbide powder is formed from a metal selected from Groups IV A, V A, VI A of the periodic system or an alloy thereof.
3. The rotary cone rock bit as set forth in either one of Claims 1 or 2 wherein the carbide powder is formed from tungsten.
- 25 4. The rotary cone rock bit as set forth in any of the preceding claims wherein the metal binder is cobalt.
- 30 5. The rotary cone rock bit as set forth in any of the preceding claims wherein the cobalt content is less than 16 percent by weight.
- 35 6. The rotary cone rock bit as set forth in any of the preceding claims wherein the particle size of the carbide is in the range of from 0.05 to 0.5 microns.

1 7. A method of enhancing the wear resistance and
toughness of sintered cemented carbide inserts
comprising the steps of;

5 compacting ultra fine tungsten carbide particles
having an average grain size of less than 1.0 micron,

 cementing said ultra fine particles with a cobalt
metal binder, and

 sintering said carbide particles and said metal
binder into suitable insert shapes.

10

8. A cemented tungsten carbide insert for use in
a gage maintenance row of a rock bit comprising
tungsten carbide powder with an average grain size of
less than 1.0 micron and a metal binder of cobalt being
15 less than 16 percent content by weight.

9. The insert as set forth in Claim 8 wherein
the carbide insert has a hardness from 92.5 Rockwell A
to 97.0 Rockwell A.

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10. The insert as set forth in Claim either one
of Claims 8 or 9 wherein the particle size of the
carbide is in the range of from 0.05 to 0.5 microns.

25

11. A cemented carbide insert for use in a rock
bit comprising carbide powder with an average grain
size of less than 1.0 micron and a metal binder
selected from the group consisting of cobalt, iron
and nickel.

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12. A rock bit substantially as described
herein with reference to the accompanying drawings.

13. An insert for use in a rock bit substantially
as described herein with reference to the accompanying
drawings.

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Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

Application number
GB 9321726.3

Relevant Technical Fields	Search Examiner R B LUCK
(i) UK Cl (Ed.M) C7A	
(ii) Int Cl (Ed.5) C22C	Date of completion of Search 21 DECEMBER 1993
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1, 8 and 9

Categories of documents

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| Y: | Document indicating lack of inventive step if combined with one or more other documents of the same category. | E: | Patent document published on or after, but with priority date earlier than, the filing date of the present application. |
| A: | Document indicating technological background and/or state of the art. | &: | Member of the same patent family; corresponding document. |

Category	Identity of document and relevant passages		Relevant to claim(s)
A	GB 1450654	(GENERAL ELECTRIC CO)	1 at least
A	GB 1266966	(FANTEEL INC)	1 at least
A	US 5009705	(MITSUBISHI METAL CORP)	1 at least
A	US 4950328	(MITSUBISHI METAL CORP)	1 at least

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Patents Act 1977
 Examiner's report to the Comptroller under Section 17
 (the Search report)

Application number
 GB 9321726.3

Relevant Technical Fields		Search Examiner R B LUCK
(i) UK Cl (Ed.M)	E1F (FGB, FGC)	
(ii) Int Cl (Ed.5)	E21B	Date of completion of Search 18 MARCH 1994
Databases (see below)		Documents considered relevant following a search in respect of Claims :- 2-7
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